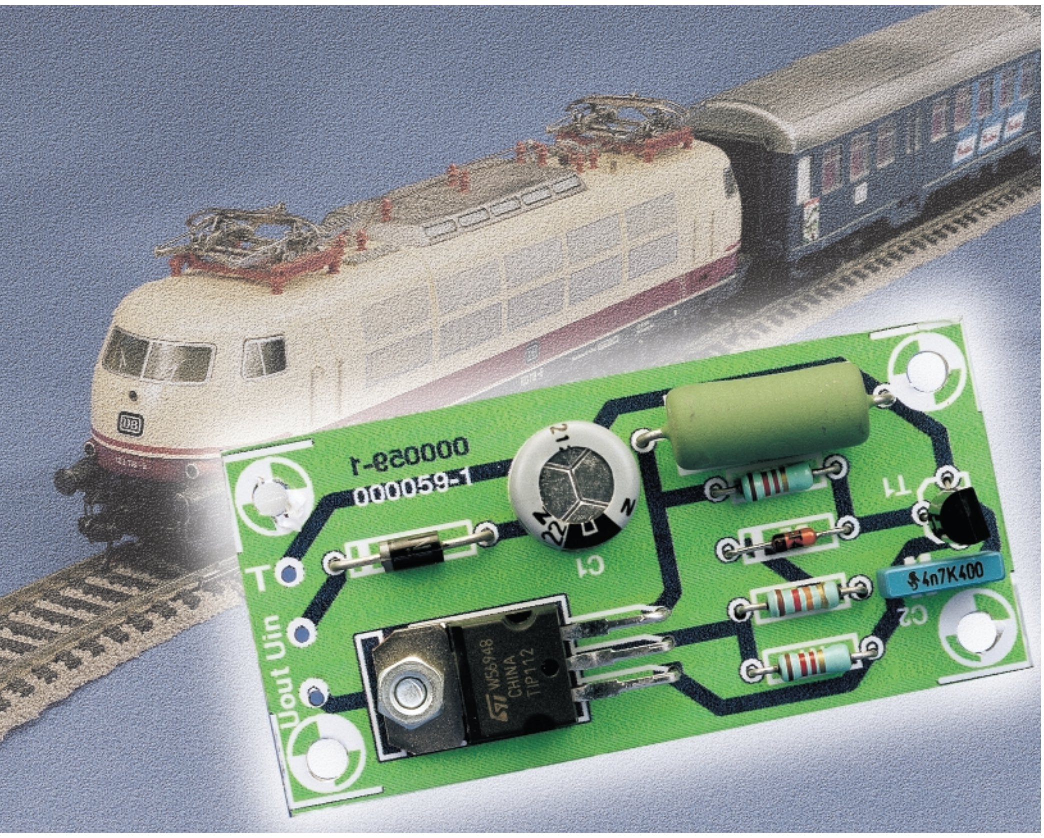
Signal Module

for EEDTs Pro

Design by H. Prince

On conventionally controlled model railways, it is standard practice to stop a train at a signal by removing power from a section of the track. With digitally controlled model trains, an auxiliary circuit must be used to prevent the locomotive decoder from losing operating power when the train is stopped.



In conventionally controlled model railways, a switch or relay is used to disconnect power from a section of the track. The train then comes to a stop on the 'dead' section. After power is restored to this section of the track via the switch or relay, the train continues on its way.

A consequence of this approach is that the front lights of the locomotive, and possibly also the lights of the first car after the locomotive, are extinguished. However, this is accepted as a necessary inconvenience.

With the advent of digitally controlled model trains, however, this inconvenience turned into a real problem. If power is completely removed from the locomotive decoder, it eventually loses its stored running settings and all information regarding enabled functions. The first generation of locomotive decoders experienced problems in such a situation within a few minutes, while modern versions can retain information for several hours.

The EEDTs Pro Super Locomotive Decoder is an exception to this rule. Since it writes the information to its EEPROM at the last possible moment, it retains this information forever.

With old format Märklin decoders, the loss of the stored information causes the default settings to be selected. This means that all functions are disabled, the running state is set to zero and the default direction is selected. If the default direction is not the same as the direction that the train was travelling when it entered the dead section of track, it will thus reverse direction when it receives new running information.

To prevent this sort of behaviour, dead sections of track are usually bridged with 1.5 kΩ resistors, and the lighting and other major power consumers are connected to a zener diode network. This arrangement is shown in **Figure 1**. If a train comes to a stop on such an 'almost dead' section of track, the decoder still

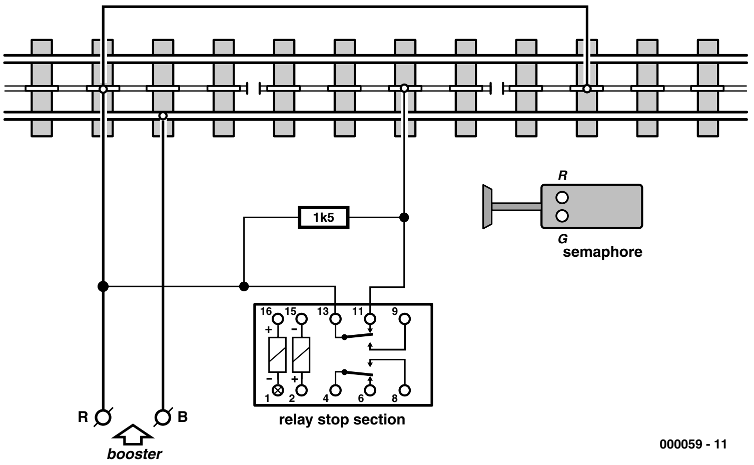


Figure 1. A 1.5-kΩ resistor can be used to ensure that the locomotive decoder receives adequate power on a 'dead' section of track.

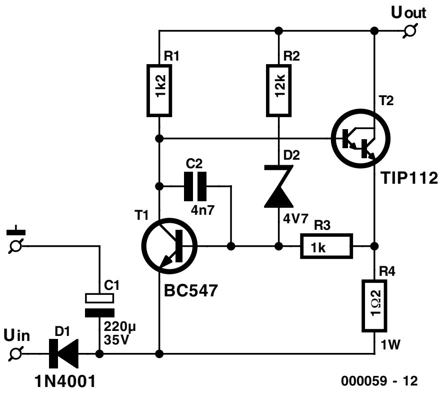


Figure 2. The electronics of the signalling module consists of two transistors and eight passive components.

receives enough power to maintain the contents of its memory.

However, the fact that the lights go out when a train enters such a section of track is still annoying, and it looks truly unprofessional if an otherwise so nicely controlled locomotive, with its finely adjusted braking deceleration, stops like a brick on such a section of track.

Fortunately, a special characteristic of the locomotive decoder provides a solution to this problem. If the decoder is fed with a negative supply voltage, any locomotive that is equipped with such a decoder will come to a stop, and the enabled functions will remain active.

This means that the front lighting remains on if it has been enabled, any sound generators that may be present are not suddenly interrupted, and the controlled locomotive decoder bring the train to a gradual stop using its deceleration settings.

The nice thing about this decoder characteristic is that in principle, it also applies to locomotive decoders made by Märklin. The only exception is the first generation of Märklin decoders, which disable the direction-dependent functions when power is interrupted.

Since the EEDTs Pro PC program can be used to automate conventionally constructed model railways with dead track sections, without any modifications being necessary, the module described here is a welcome addition to the EDiTS toolkit.

The circuit

It is not possible to simply apply a negative voltage to the rails of a stop section, since the slider contact makes a connection between the stop section rail and the booster output when the locomotive enters such a section of track. The unpleasant consequence of this is that enormous currents can flow. The booster output provides an alternating voltage that switches between –20 and +20 V, so that at any given moment 20 V will be shorted to ground through the slider.

With a three-rail system, a short circuit can be prevented by inserting a length of insulation in the slider rail, so that the slider does not make contact with the rail in the stop section until it has broken contact with the rail in the normal section of the track. With a two-rail system, however, it is not possible to prevent the slider from making contact with the rails of both sections when the locomotive enters a stop section.

The circuit shown in **Figure 2** is thus designed to limit the current to 0.5 ampère. This value has been chosen to allow enough power to be provided for locomotive braking, other functions and lighting (if enabled). It should be sufficient in nearly all cases.

Capacitor C1 and diode D1 derive a negative voltage from the rail voltage. When a load is applied to the circuit, T2 is driven into conduction by R1 until the voltage drop across R4 rises to more than around 0.6 V. At this point, T1 starts to conduct. This reduces the drive current to T2, which in turn causes the current through R4 to decrease until a balance is achieved. This occurs when the voltage drop

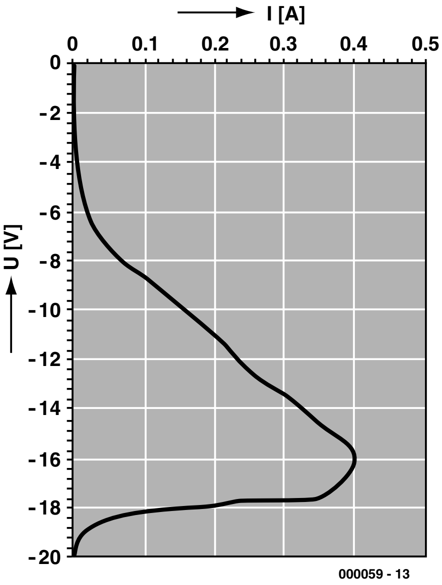


Figure 3. The current limitation characteristics of the signalling module.

across R4 is 0.6 V. The circuit then limits the current to approximately 500 mA (0.6 / 1.2). However, since 20 V can be applied to T2 when the circuit is bridged by the slider, the power dissipated in T2 will be around 10 W (which also puts a heavy additional load on the booster). To prevent this unnecessary waste of power, the circuit has a power limitation network in the form of D2 and R2. These components cause the circuit to work only within the range of –20 V to –15 V. Outside of this range, the circuit will not supply any current (see the diagram in **Figure 3**).

If the voltage across the C-E junction of T2 rises above the zener voltage (4.7 V), T1 is driven even harder. This causes T2 to completely cut off, so that no current at all flows through T2 and R4. Capacitor C2 is included in the circuit to prevent any instability due to feedback.

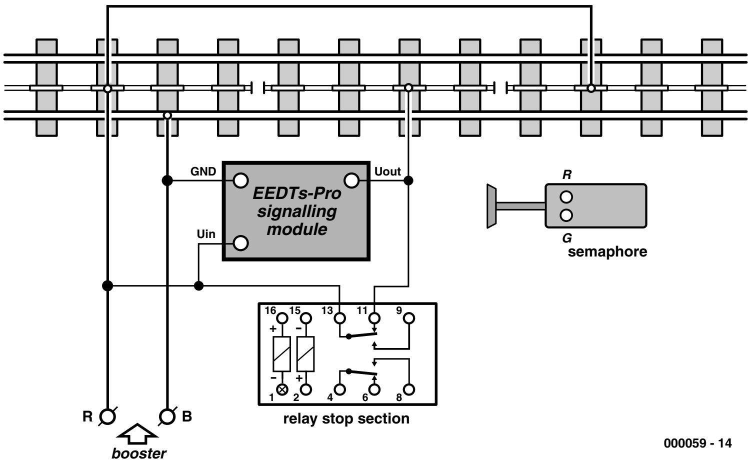


Figure 4. Connecting the signalling module to a stop section.

Since this circuit can be short-circuited without any ill effects, it can easily be used to replace the original 1.5-kΩ resistor shown in **Figure 1**. This means that conventionally wired stop sections can be used without any modifications (see **Figure 4**).

On all two-rail model railways, the rail leads of the locomotive decoder can be connected either way around. This means that the locomotive decoder must be able to interpret both +20 V and –20 V on a stop section. The super decoder responds properly to both voltages. We have not checked whether all reversible-polarity Märklin decoders also respond correctly to a +20 V stop section. However, we expect that they would, so they could also be used on two-rail systems that are fitted with EEDTS Pro signalling modules.

The deceleration (braking) behaviour of the decoder must naturally be taken into account in determining the length of the stop section. Space is often a problem with model railways, but you still must reserve at least half a metre for each stop section.

The layout of the printed circuit board is shown in **Figure 5**. This board is so simple that it is not available ready-made from Readers Services. A handy hobbyist can easily etch such a board himself, or a piece of prototyping board can be used to construct the circuit.

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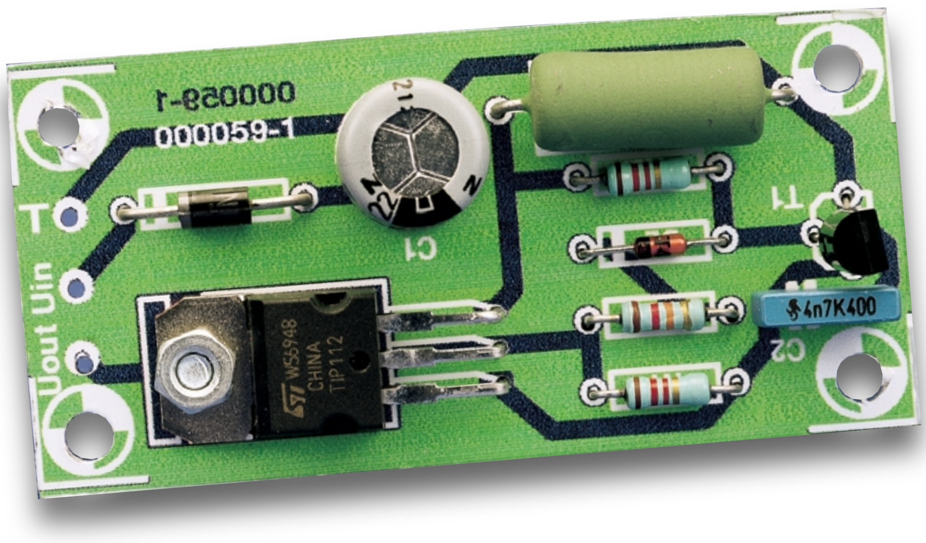

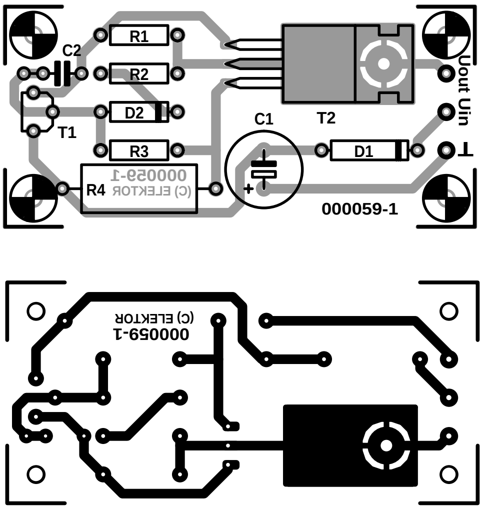

Figure 5. Printed circuit board layout for the signalling module.

COMPONENTS LIST

Resistors:
R1 = 1kΩ2
R2 = 12kΩ
R3 = 1kΩ
R4 = 1Ω2/1W

Capacitors:
C1 = 220μF 35V radial
C2 = 4nF7

Semiconductors:
D1 = 1N4001
D2 = 4V7zener diode
T1 = BC547
T2 = TIP112